

# Geologic Resource Evaluation Scoping Summary Hubbell Trading Post National Historic Site, Arizona

Geologic Resources Division  
National Park Service  
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Administered by the NPS Geologic Resources Division (GRD), the Geologic Resource Evaluation (GRE) Program provides each of 270 identified natural-area units in the National Park System with a geologic scoping meeting, a digital geologic map, and a geologic resource evaluation report. The purpose of scoping is to identify geologic mapping coverage and needs, distinctive geologic processes and features, resource management issues, and potential monitoring and research needs. Outcomes of this scoping process are a scoping summary (this report), a digital geologic map, and a geologic resource evaluation report. Participants at the geologic scoping meetings evaluate the adequacy of existing geologic maps for resource management, discuss park-specific geologic management issues, and if possible tour the site with park staff and geologists knowledgeable about the park's geologic resources.

The National Park Service held a GRE scoping meeting for Hubbell Trading Post National Historic Site on February 16, 2007. Participants at the meeting included NPS staff from the historic site, Canyon de Chelly National Monument, and the Geologic Resources Division, and cooperators from Colorado State University (CSU) and Northern Arizona University (NAU) (table 1). Ron Blakey (NAU) gave an impromptu presentation about the geology of the national historic site, having spent significant time in the area. Tim Connors (GRD) facilitated the evaluation of map coverage, and Lisa Norby (GRD) led the discussion regarding geologic processes and features. After discussions, which took place at Canyon de Chelly National Monument, Connors (GRD), Norby (GRD), and KellerLynn (CSU) met Anne Worthington (HUTR) at the trading post for a brief tour/reconnaissance of the site. They also spoke with Lawrence Woody (HUTR) about some geologically related issues.

This scoping summary highlights the GRE scoping meeting for Hubbell Trading Post National Historic Site, including the geologic setting, the plan for providing a digital geologic map, a list of geologic resource management issues, descriptions of significant geologic features and processes, and a record of meeting participants.

## Park and Geologic Setting

Hubbell Trading Post National Historic Site lies along Pueblo Colorado Wash in the Four Corners area of Arizona. The Pueblo Colorado Wash is a broad, deep streambed that cuts the north side of the national historic site. Established in the 1870s, Hubbell Trading Post is the oldest continuously operating trading post in the Navajo Nation. The site was designated as a national historic landmark in 1960 and became a national historic site in 1965. Hubbell's daughter-in-law, Dorothy, lived at the trading post until 1967, when it was purchased by the National Park Service. Today, employees of the cooperating association, Western National Parks Association, operate the trading post's store. The site consists of the Hubbell homestead, trading post, visitor center, wareroom, wareroom extension, barn, guest hogan, chicken coop, bread oven, bunkhouse, hogan-in-the-lane, root cellar, corrals, various sheds, and park housing. In 1878 John Lorenzo Hubbell purchased the store from William Leonard. At various times with his partner, C. N. Cotton, or with his sons, Hubbell had interests in more than 30 trading operations around the Navajo Nation and in southern California. Hubbell became known as "Don" Lorenzo, a Spanish title of honor. To the Navajo, his wire-rimmed glasses earned him the name Ná'ee Sinilí, "Eyeglasses."

Trading posts, and individual traders, served many functions. They sometimes housed and fed their customers, furnished important ceremonial items, accepted silver and turquoise jewelry as "pawn" for loans,

hired local people, gave legal help, and occasionally even rendered medical assistance (Houk, 2005). Hubbell, a trusted friend of many Navajo people, also translated and wrote letters, settled family quarrels, and explained government policy. When a smallpox epidemic swept the reservation in 1886, Hubbell worked day and night caring for the sick and dying, using his own home as a hospital.

John Lorenzo Hubbell died in 1930 and was buried in the family cemetery on Hubbell Hill, which overlooks the trading post (fig. 1). Beside him are his wife, Lina, three of their children, and his dear Navajo friend, Bi'lii Lani ("Many Horses"). Following Navajo custom, Hubbell's grave is not marked. Though not presently NPS property, Hubbell Hill could potentially be included as part of the national historic site at some future point (Anne Worthington, HUTR, personal communication, February 16, 2007).



**Figure 1.** Hubbell Trading Post National Historic Site. Hubbell Hill, composed of Triassic Chinle Formation, lies just outside the historic site's boundary. J. L. Hubbell's unmarked grave is on Hubbell Hill. NPS photo by Katie KellerLynn

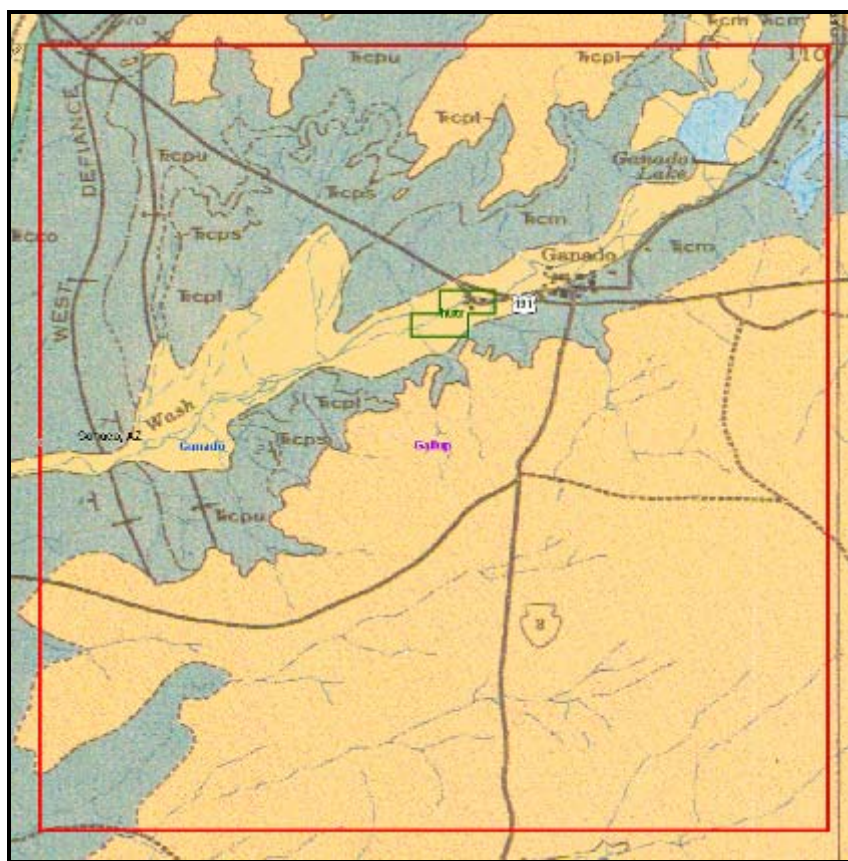
With the exception of alluvial deposits of the Pueblo Colorado, Hubbell Hill and all the surrounding landscape consist of the Monitor Butte Member (lower portion) of the Chinle Formation. The Chinle Formation is known for its fossils (e.g., at Petrified Forest National Park) and its potential for swelling soils and uranium. The Chinle strata dip gently to the west at the trading post. The Pueblo Colorado Wash cut into an erosional surface, which lies to the south and was created at the same time as uplift of the Defiance Plateau. The Defiance uplift, of which the Defiance Plateau is the modern expression, is related to the Pennsylvanian-age Ancestral Rocky Mountains of Colorado and neighboring areas. The uplift is an elongated region that extends more than 100 miles (161 km) from the Four Corners area to Interstate 40 in southern Arizona. Plate convergence associated with the assembly of the supercontinent Pangaea resulted in this uplift, which also reexposed Precambrian rocks (i.e., schist, gneiss, and granite) in portions of the state.

Surficial deposits at Hubbell Trading Post include modern alluvium, older inactive alluvium, gentle badlands topography, and possibly dunes. The Miocene Bidahochi Formation, which tops the mesas in the vicinity of Hubbell Trading Post, was deposited by streams and in playa lakes. The organically rich, sandy-muddy

deposits of the Bidahochi Formation were significant for interpreting the history of the uplift of the Colorado Plateau (Ron Blakey, NAU, personal communication, February 16, 2007), of which Hubbell Trading Post National Historic Site is a part.

## Geologic Mapping Plan for Hubbell Trading Post National Historic Site

During the scoping meeting, Tim Connors (GRD) showed some of the main features of the GRE Program's digital geologic maps, which reproduce all aspects of paper maps, including notes, legend, and cross sections, with the added benefit of being GIS compatible. The NPS GRE Geology–GIS Geodatabase Data Model incorporates the standards of digital map creation set for the GRE Program. Staff members digitize maps or convert digital data to the GRE digital geologic map model using ESRI ArcGIS software. Final digital geologic map products include data in geodatabase, shapefile, and coverage format, layer files, FGDC-compliant metadata, and a Windows HelpFile that captures ancillary map data. Completed digital maps are available from the NPS Data Store at <http://science.nature.nps.gov/nrdata/>.



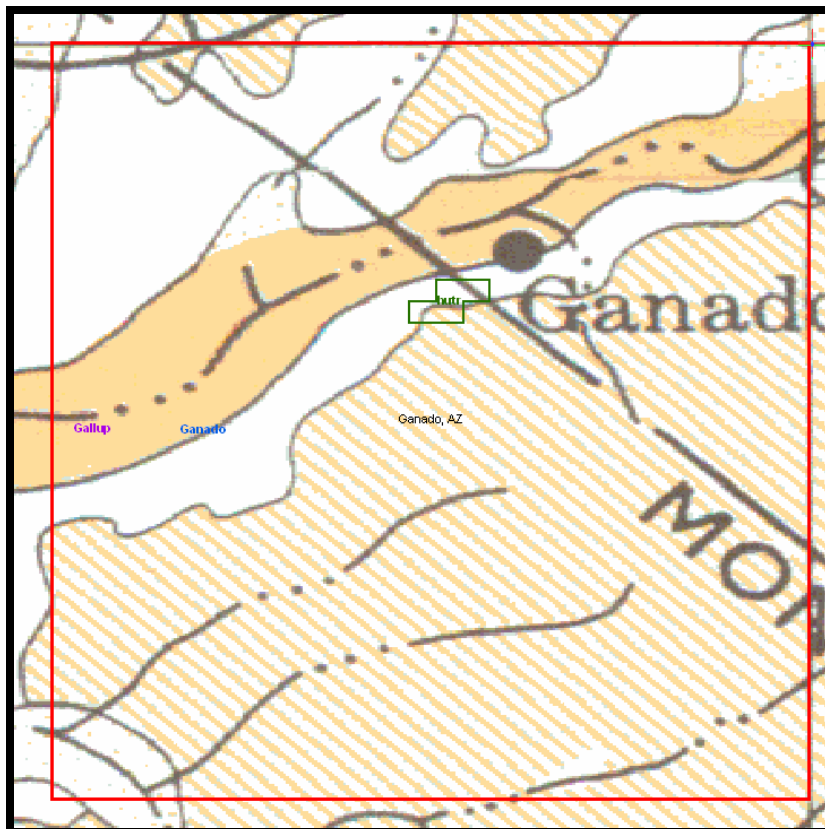
**Figure 2.** Bedrock Geologic Map. Plate 1 (sheet 6) of USGS Professional Paper 521-A (GMAP 74603) shows the bedrock geology at Hubbell Trading Post National Historic Site. This figure highlights the Ganado 7.5' quadrangle (red outline) and HUTR boundary (green outline).

Hubbell Trading Post National Historic Site (HUTR) is situated on the Ganado 7.5' quadrangle (figs. 2 and 3). Known published geologic map coverage is available for this quadrangle as part of USGS Professional Paper 521-A. While the map scale of this publication is coarse (1:125,000), scoping evaluation determined that this map is adequate for resource management at the national historic site. However, investigators from Northern Arizona University are willing to conduct a geologic reconnaissance at the site, which they estimate would take a day or two; this could further refine the geologic map. The selected map (i.e., GMAP 74603) is not known to exist in a digital-GIS format, so GRE staff will digitize the source map and create a geodatabase

from it. GRE staff has assigned a unique “GMAP ID” for each map, which is used for data management purposes; these numbers appear in table 2 and with the map citations in this summary.

To provide digital geology for the Ganado 7.5' quadrangle, GRE staff will use the following sources:

- **“Geologic”**—(74603) Cooley, M.E., Harshbarger, J.W., Akers, J.P., Hardt, W.F., and Hicks, O.N., 1969, Geologic map of the Navajo and Hopi Indian reservations, Arizona, New Mexico, and Utah (sheet 6 of plate 1), *in* Regional hydrogeology of the Navajo and Hopi Indian reservations, Arizona, New Mexico, and Utah: U.S. Geological Survey Professional Paper 521-A, 5 plates, scale 1:125,000 (see fig. 2).
- **“Surficial”**—(74606) Cooley, M.E., Harshbarger, J.W., Akers, J.P., Hardt, W.F., and Hicks, O.N., 1969, Map showing surficial deposits, volcanic provinces, internally drained areas, streamflow data, and occurrence of water in the alluvium in the Navajo and Hopi Indian reservations, Arizona, New Mexico, and Utah, *in* Regional hydrogeology of the Navajo and Hopi Indian reservations, Arizona, New Mexico, and Utah with a section on vegetation (plate 2): U.S. Geological Survey Professional Paper 521-A, 5 plates, scale 1:500,000 (see fig. 3).



**Figure 3.** Surficial Geologic Map. Plate 2 of USGS Professional Paper 521-A (GMAP 74606) shows the surficial geology at Hubbell Trading Post National Historic Site. This figure highlights the Ganado 7.5' quadrangle (red outline) and HUTR boundary (green outline).



## **Geologic Features, Processes, and Resource Management Issues**

The scoping session for Hubbell Trading Post National Historic Site provided the opportunity to develop a list of issues that may be of concern to park managers, as well as a list of geologic features and processes at the site. These issues, features, and processes will be further explained in the final GRE report. During scoping, participants did not prioritize these issues, features, and processes, so they are listed in alphabetical order here.

### **Disturbed Lands**

More than 315,000 acres (127,480 ha) in 195 National Park System units have been disturbed by modern human activities. Some of these features may be of historical significance, but most are not in keeping with the mandates of the National Park Service. Disturbed lands are those park lands where the natural conditions and processes have been directly impacted by development (e.g., facilities, roads, dams, abandoned campgrounds, and user trails), agricultural practices (e.g., farming, grazing, timber harvest, and abandoned irrigation ditches), overuse, or inappropriate use. Usually, lands disturbed by natural phenomena such as landslides, earthquakes, floods, hurricanes, tornadoes, and fires are not considered for restoration unless influenced by human activities.

Restoration activities return the quality and quantity of an area, watershed, or landscape to some previous condition, often some desirable historic baseline. Restoration at disturbed areas directly treats the disturbance to accelerate site recovery and should aim to permanently resolve the disturbance and its effects. For more information about disturbed lands restoration, contact Dave Steensen (GRD, Restoration Program lead) at [dave\\_steensen@nps.gov](mailto:dave_steensen@nps.gov) or 303-969-2014.

Runoff from roads is a disturbance that causes erosional gullies at the national historic site. Park staff may require some technical assistance for implementing proper drainage off roads. In addition, sinkholes, which are assumed to be a result of groundwater withdrawal, are forming in fields northeast of the trading post. This could become a problem for park managers in the future, but no such features have formed on National Park System lands at present.

### **Fluvial Features and Processes**

Pueblo Colorado Wash and another unnamed tributary run through Hubbell Trading Post National Historic Site. Typically, even during dry periods, the wash maintains at least a “trickle” of flow. Starting in 2003 the National Park Service began a program to restore the riparian corridor via removal of exotic plants and planting of native species. This effort is resulting in a return of the natural meandering of the stream channel, which was interrupted by a period of rapid downcutting along unnaturally straight reaches. The Pueblo Colorado Wash is part of the interpretive program at the historic site; interpreters discuss the restoration project as well as the importance of the wash as a water supply for trading-post inhabitants.

Regulated flow from the dam at Ganado Lake, northeast of Hubbell Trading Post, is a source of irrigation water for the historic site and surrounding area; one of the fields at Hubbell Trading Post is irrigated. Irrigation in the area is part of the Ganado Irrigation System, which has recently undergone repairs (see [http://www.doi.gov/partnerships/irrigation\\_systems.html](http://www.doi.gov/partnerships/irrigation_systems.html)). Although the dam is an economic centerpiece of the Navajo Nation, its function results in a lack of natural streamflow, including flooding and sediment movement, which affects the riparian habitat at Hubbell Trading Post National Historic Site.

As an attempt to control erosion and protect cultural sites in the 1970s and 1980s, the National Park Service installed and maintained stone gabions along the stream bank at Hubbell Trading Post. One of these gabions currently protects a Pueblo ruin near the entrance sign/flagpole of the trading post, but similarly protected

archaeological sites are experiencing fluvial erosion. Hence, the effectiveness and value of using these types of erosion control structures are under question.

## **Geothermal Resources**

The buildings at Hubbell Trading Post are heated and cooled by geothermal heat pumps. A combination of nine wells behind the visitor center and 25 wells in the barnyard provide the resources necessary to supply the system. Engineers at the NPS Denver Service Center designed the system. During scoping, participants speculated that the source of the thermal water was probably the Chinle Formation; however, more research will be conducted and information provided in the final GRE report.

## **Mass-Wasting Processes**

During scoping, participants mentioned that sudden rain events have resulted in sheet flow at the national historic site. On one occasion, the flow was great enough to transport a large log—estimated to be 6–8 feet (1.8–2.4 m) long and 8–10 inches (20–25 cm) in diameter (Ailema Benally, CACH, e-mail communication, April 20, 2007)—through the trading post’s parking lot.

## **Soils**

The NPS Soils Program hosted a soils scoping session for Hubbell Trading Post in January 2005. The soil resources inventory for Hubbell Trading Post will begin during the first quarter of fiscal year 2008, after the current project at Canyon de Chelly National Monument is completed. The mapping will be done to National Cooperative Soil Survey (NCSS) standards at an Order 2 level, with base orthophoto imagery (scale 1:12,000). Emphasis will be placed on documenting the relationships of soil types to the current and past cultural landscapes, as well as applications to park management needs. Information applicable to soil resource management, crop productivity, and irrigation water management will be developed. In addition, development of ecological site descriptions for the rangeland areas of the site will be part of the inventory. The National Park Service and Natural Resources Conservation Service will coordinate the development of a work plan and initiate the permit process prior to any mapping. For more information about soil resources, contact Pete Biggam (NPS soils scientist) at [pete\\_biggam@nps.gov](mailto:pete_biggam@nps.gov) or 303-987-6948.

Swelling soils are associated with the Chinle Formation, which is the bedrock unit at Hubbell Trading Post National Historic Site. Issues related to swelling soils may include heaving sidewalks and roads and failing foundations in park housing. However, heaving and subsidence may be a result of other factors such as building sites located on improperly compacted (subsiding) fill material or improper drainage around foundations (Pete Biggam, GRD, e-mail communication, February 23, 2007). Aside from a few cracks in the hogan at Hubbell Trading Post and cracked foundations in the newly constructed park housing, park staff is not aware of any problems related to swelling soils. Furthermore, initial observations at the time of the soil scoping session suggest that poor site selection and development are the primary factors of seemingly swelling soil-related problems in the housing area (Pete Biggam, GRD, e-mail communication, February 23, 2007). During construction, the building site was “over-excavated” (Lawrence Woody, HUTR, personal communication, February 16, 2007) and much fill material was brought in. Also, Pete Biggam observed that water from downspouts was not being channeled far enough away, if at all, from structures. Hence, the “cracking” of some floors in park housing most likely is not a result of swelling soil. Nevertheless, a site visit by a soil scientist could confirm the source of the problem.

## **Mineral Resources and Mining**

The Bidahochi Formation, found on mesa tops in the vicinity of Hubbell Trading Post National Historic Site, was deposited in the playa lakes of a shallow basin during the Miocene Epoch (14–7 million years ago). This formation is known for its uranium content. The most significant Bidahochi mines were Boot Jack Mine, Fern 1 Mine, Bidahochi Butte prospects, and the Calvin Chee prospect (see USACE project summary at <http://yosemite.epa.gov/r9/sfund/techdoc.nsf/5e2227f65e9593fc8825657100021ab0/ef79cc15e39bbe218825>

[7169005b9722/\\$FILE/AppendixA4a.pdf](#)). As of February 14, 2007, the Navajo Abandoned Mine Land (AML) Reclamation Department had reclaimed two of these mines, with no mines remaining with environmental problems (see [http://www.aml.navajo.org/Accomplishment\\_Benefits.htm](http://www.aml.navajo.org/Accomplishment_Benefits.htm)). These mines were located south of the trading post in the Navajo Nation, Navajo County, Arizona.

## References

Houk, R., 2005, Hubbell Trading Post National Historic Site, *in* The guide to national parks of the Southwest: Tucson, Arizona, Western National Parks Association, p. 55.

Cooley, M.E., Harshbarger, J.W., Akers, J.P., Hardt, W.F., and Hicks, O.N., 1969, Regional hydrogeology of the Navajo and Hopi Indian reservations, Arizona, New Mexico, and Utah, with a section on vegetation: U.S. Geological Survey Professional Paper 521-A, 60 p., 12 plates.

**Table 1. Scoping Meeting Participants**

Name	Affiliation	Position	Phone	E-Mail
Ailema Benally	NPS-CACH (formerly at HUTR)	Interpreter	928-674-5500 x. 227	ailema_benally@nps.gov
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Lisa Skinner	Northern Arizona University	Geologist/GIS	928-699-1352	lisa.skinner@nau.edu
Paul Umhoefer	Northern Arizona University	Geologist	928-523-6464	paul.umhoefer@nau.edu
Lawrence Woody	NPS-HUTR	Maintenance Supervisor	928-755-3475 x. 3477	lawrence_woody@nps.gov
Anne Worthington	NPS-HUTR	Superintendent	928-755-3475	anne_worthington@nps.gov

**Table 2. GRE List of Maps for Hubbell Trading Post National Historic Site**

GMAP ID	Reference	Appraisal	GRE action required	URL	Scale
74603	Cooley, M.E., Harshbarger, J.W., Akers, J.P., Hardt, W.F., and Hicks, O.N., 1969, Geologic map of the Navajo and Hopi Indian reservations, Arizona, New Mexico, and Utah (sheet 6 of plate 1), <i>in</i> Regional hydrogeology of the Navajo and Hopi Indian reservations, Arizona, New Mexico, and Utah: U.S. Geological Survey Professional Paper 521-A, scale 1:125,000.	2007-0305: covers entire HUTR quadrangle of interest (QOI) at 1:125,000; looks appropriately detailed for what GRE staff observed during site visit. GRE will crop to the Ganado 7.5' quadrangle from this larger map and digitize as it is not known to exist in digital format.	Digitization	E:\gis-nps\_by_gmap_id\74603_navajo-hopi_hydro_plate-1_sheet-6	125000
74606	Cooley, M.E., Harshbarger, J.W., Akers, J.P., Hardt, W.F., and Hicks, O.N., 1969, Map showing surficial deposits, volcanic provinces, internally drained areas, streamflow data, and occurrence of water in the alluvium in the Navajo and Hopi Indian reservations, Arizona, New Mexico, and Utah, <i>in</i> Regional hydrogeology of the Navajo and Hopi Indian reservations, Arizona, New Mexico, and Utah with a section on vegetation (plate 2): U.S. Geological Survey Professional Paper 521-A, scale 1:500,000.	2007-0305: covers entire HUTR QOI at 1:500,000; looks appropriately detailed for what GRE staff observed during site visit. GRE will crop to the Ganado 7.5' quadrangle from this larger map and digitize as it is not known to exist in digital format.	Digitization	E:\gis-nps\_by_gmap_id\74606_navajo-hopi_hydro_plate-2	500000